REMARKS

The applicants and the undersigned attorney extend their gratitude to substitute Examiner Trinh for the courtesies extended during the personal interview of October 12, 2006. The discussions of this interview focused on why the claims set forth herein overcome the outstanding final rejections.

This paper is presented in response to the official action dated May 5, 2006, wherein: **(a)** claims 1, 3-8, 10-13, 47, and 48 were pending; **(b)** claims 1, 3-8, 11-13, 47, and 48 were rejected under 35 USC § 102(b) as anticipated by Falster et al., U.S. Patent No. 5,994,761 ("Falster"); and, **(c)** claims 1, 3, and 4 were rejected under 35 USC § 102(b) as anticipated by Nadahara et al., U.S. Patent No. 5,994,761 ("Nadahara"). Reconsideration and withdrawal of the rejections are respectfully requested in view of the foregoing amendments and following remarks.

This paper is timely filed as it is accompanied by a petition under 37 CFR § 1.136(a) for an extension of time to file in the 3rd month, and payment of the required extension fee.

An explicit basis for the rejection of claim 10 was not provided in the official action. In view of this omission, applicants respectfully submit that any subsequent official action first rejecting claim 10 in this application must be made non-final.

I. Brief Summary of the Amendments to the Claims

Claims 1, 4, 8, and 11 have been amended to explicitly label the "direction from the front surface to the back surface" as the "axial" direction and likewise to explicitly label the "direction from the central axis to the circumferential edge portion" as the "radial" direction. These labels are intended for the sake of clarity, because the existing structurally recited directions (i.e., "from the front surface to the back surface" and "from the central axis to the circumferential edge portion") already define two directionally distinct concentration distribution directions.

Claims 1, 4, 8, and 11 have been further amended to recite a "first concentration distribution" instead of a "first concentration profile."

Claims 6 and 13 have been amended to recite "the radial direction" defined in their respective independent claims.

No change in claim scope is intended or effected by any of the foregoing amendments.

New dependent claims 49-52 recite that "the first and second denuded zones are substantially free from" either "oxygen precipitates and bulk stacking faults" (claims 49 and 51) or "bulk stacking faults" (claims 50 and 52). Support for these limitations can be found, for

example, at p. 5, lines 16-18; p. 25, lines 13-18; and, Fig. 8. New claim 49 also recites the limitations of claim 6. No fee is due for these additional claims.

No new matter has been introduced by the foregoing amendments.

II. The 35 USC § 102(b) Rejection Is Traversed

Claims 1, 3-8, 11-13, 47, and 48 were rejected under 35 USC § 102(b) as anticipated by Falster. *See* pp. 3-4 of the action. Claims 1, 3, and 4 were rejected under 35 USC § 102(b) as anticipated by Nadahara. *See* p. 4 of the action.

A. Proper Basis for a § 102(b) Rejection

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631 (Fed. Cir. 1987).

B. The § 102(b) Rejection Is Traversed

It is respectfully submitted that the pending claims are not anticipated by either Falster or Nadahara.

1. The Disclosure of the Applied References

Falster is directed to an oxygen out-diffusionless process for oxygen precipitating silicon wafers. Falster only discloses oxygen precipitate defects, and does not disclose any bulk stacking fault defects. *See* Falster, at col. 2, lines 14-21. Additionally, Falster only discloses oxygen precipitate defect concentrations and axial distributions thereof in a direction from the front surface to the back surface of the wafer:

> After oxygen precipitation heat-treatment step S_4 . . . , the resulting *depth distribution* of oxygen precipitates in the wafer is characterized by clear regions of oxygen precipitate-free material (denuded zones) 15 and 15' extending from the front surface 3 and back surface 5 to a depth t, t', respectively. Between these oxygen precipitate-free regions, is a region 17 containing a substantially uniform density of oxygen precipitates.

Falster, at col. 7, lines 57-67 (emphasis added). Falster discloses that the concentration of oxygen precipitates ranges from about 1×10^7 to about 5×10^{10} precipitates/cm^3. Falster, at col. 8, lines 3-7.

Nadahara is directed to a method for heat treating a semiconductor substrate to reduce defects. Even though Nadahara uses the term "BMD," it only refers to oxygen precipitate defects. For example, when discussing heat treatment steps for a silicon wafer, Nadahara states:

> nuclei 13 of oxygen precipitates are ideally formed in an intermediate layer 14 within the silicon wafer 1, as shown in

> FIG. 11b. Further, the silicon wafer 1 is subjected to a heat treatment at a temperature of about 1000 °C in the subsequent step of, for example, forming a field oxide film, with the result that precipitate grows about each of the nuclei 13 to form BMD 15 with a high concentration.

Nadahara, at col. 1, lines 54-64. Further, Nadahara only discloses oxygen precipitate axial distributions in a direction from the front surface to the back surface of the wafer. *See* Nadahara, at col. 4, lines 8-11 (describing the defect density as varying with the "distance from the upper surface"); and *see also* Figs. 2, 5, and 9.

2. The Applied References Do Not Disclose the Claimed Distribution of Defects

Independent claims 1 and 4 recite that "a second concentration distribution of defects in the bulk region is maintained substantially constant in a radial direction." Similarly, independent claims 8 and 11 recite "a second concentration distribution of defects in the bulk region has a range of variation of about 10% or less in a radial direction."

Falster merely discloses substantial uniformity of oxygen precipitate defects in the axial direction. Figure 5 discloses a single axial distribution of vacancies in a wafer; these vacancies ultimately form oxygen precipitates. *See* Falster, at Fig. 5 and col. 7, lines 42-55. When characterizing the distribution of oxygen precipitates, Falster refers to a "depth distribution." Falster, at col. 7, lines 60-61. Further, the density of oxygen precipitates is described as substantially uniform between the oxygen precipitate-free regions on the front and back surfaces of the wafer (i.e., in the axial direction). Falster, at col. 7, lines 63-67. Given the single figure plotting the vacancy concentration (which vacancies ultimately become oxygen precipitates) as a function of depth and the reference to a depth distribution, the skilled artisan would interpret Falster's disclosure relating to defects as teaching substantial uniformity only in the axial direction. Accordingly, Falster is silent with respect to radial defect distributions in the direction from the central axis to the circumferential edge portion of the wafer.

Nadahara discloses only axial defect distributions, and thus also fails to disclose the recited radial distribution of defects. Specifically, Nadahara describes its disclosed defect density as varying with the "distance from the upper surface" (i.e., in the axial direction). Nadahara, at col. 4, lines 8-11. Similarly, Nadahara presents three defect density distributions, all of which are shown as a function of "depth" (i.e., a function of the axial coordinate), and there are no figures disclosing or suggesting a substantially constant defect distribution in the radial direction. *See* Nadahara, at Figs. 2, 5, and 9. Thus, the skilled artisan would interpret Nadahara's disclosure relating to defects as teaching substantial uniformity only in the axial direction. Accordingly, Nadahara is silent with respect to radial

defect distributions in the direction from the central axis to the circumferential edge portion of the wafer.

As the aforementioned radial distribution limitations are not disclosed by Falster or Nadahara, the examiner appears to be relying on the doctrine of inherency to demonstrate these limitations. However, "[t]o establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency . . . may not be established by probabilities or possibilities." *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999); *see also* MPEP § 2112. Nothing in Falster or Nadahara discloses or even suggests that the disclosed wafers have radial defect distributions as recited in independent claims 1, 4, 8, and 11. Moreover, Falster and Nadahara provide no evidence of any necessary correlation between axial concentration distributions and radial concentration distributions.

Figure A, below, qualitatively illustrates that a defect distribution that is substantially constant in the axial direction is not necessarily substantially constant in the radial direction. In fact, Figure A illustrates that it is possible for a defect distribution in the bulk zone of a silicon wafer to be substantially constant in the *axial direction* and simultaneously variable in the *radial direction*.

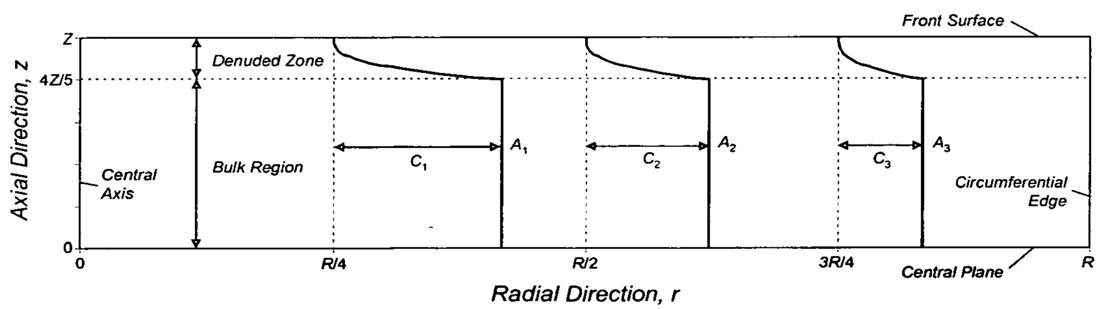

Figure A

Specifically, Figure A illustrates a cross-section of a disk-shaped silicon wafer having a half-height Z and a radius R in the r-z plane of a cylindrical coordinate system. The central axis of the wafer is located at $r = 0$, and the circumferential edge of the wafer is located at $r = R$. The central plane of symmetry of the wafer is located at $z = 0$, and the front surface of the wafer is located at $z = Z$. The first denuded zone is located from $z = 4Z/5$ to Z, and is substantially constant in the radial direction (i.e., the denuded zone depth is substantially constant from $r = 0$ to R). The second denuded zone is not shown in the illustrated portion of the wafer. The bulk region is located from $z = 0$ to $4Z/5$. The numerical values provided in Figure A are provided for explanatory purposes.

Figure A also illustrates three qualitative defect distributions A_1, A_2, A_3 at three different radial positions $r = R/4$, $R/2$, $3R/4$ (i.e., the distributions A_1, A_2, A_3 are axial distributions). As illustrated, all three distributions A_1, A_2, A_3 are substantially constant in the axial direction in the bulk region. As illustrated, however, each of the three distributions A_1, A_2, A_3 has a different concentration in the bulk region (denoted by C_1, C_2, and C_3, respectively). Thus, the defect concentrations are not substantially constant in the radial direction even though the defect concentrations are substantially constant in the axial direction. Because it is possible for a defect distribution to be substantially constant in the axial direction and simultaneously variable in the radial direction, a disclosure that a particular wafer has a substantially constant distribution of defects in the axial direction (e.g., as in Falster and Nadahara) provides an insufficient basis to conclude that the same must necessarily be true in the radial direction.

In view of the foregoing, the applicants submit that Falster and Nadahara each fail to disclose both the recited axial and radial distribution of defects. Thus, all pending claims should be allowed over the applied references.

Moreover, claims 1, 4, 8, and 11 recite either the concentration distributions of oxygen precipitates and bulk stacking faults (claims 1 and 8) or the concentration distributions of bulk stacking faults (claims 4 and 11). Falster and Nadahara disclose only the presence of oxygen precipitates (*see* Section II.B.1 above) and they are entirely silent with respect to bulk stacking faults, as explained in more detail in Section II.B.3 below.

3. The Applied References Do Not Disclose Any Bulk Stacking Faults

Each of independent claims 1, 4, 8, and 11 positively recites a silicon wafer including substantially constant distributions including bulk stacking fault defects in the axial and radial directions. Because Falster and Nadahara only disclose oxygen precipitates (*see* Section II.B.1 above), the skilled artisan would understand that neither reference discloses or contemplates the existence of bulk stacking faults.

As the aforementioned bulk stacking fault limitations are not disclosed by Falster or Nadahara, the examiner appears to be relying on the doctrine of inherency to demonstrate these limitations. However, "[t]o establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency . . . may not be established by probabilities or possibilities." *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999); *see also* MPEP § 2112. Nothing in Falster or Nadahara discloses or even suggests that the disclosed wafers have bulk stacking faults as recited in independent claims 1, 4, 8, and 11. Moreover, Falster and Nadahara provide no evidence of any necessary correlation between oxygen precipitates and bulk stacking faults.

Further, dependent claims 5 and 12 recite that the bulk stacking fault concentration "in the region between the first and the second denuded zones has a distribution which is maintained constant in a range from about 1.0×10^8 ea/cm^3 to about 3.0×10^9 ea/cm^3." Claims 5 and 12 were not rejected over Nadahara, and Falster only discloses the concentration of oxygen precipitates, not bulk stacking faults. *See* Section II.B.1 above. For this additional independent reason alone, claims 5 and 12 should be allowed over the applied references.

4. The Applied References Do Not Disclose the Claimed Denuded Zone Depth

Dependent claims 6 and 13 recite that "the distances of the first and the second denuded zones from the front and back surfaces . . . are substantially constant in the radial direction."

As discussed in Section II.B.2 above, Falster and Nadahara are silent with respect to the radial distribution of any property of their disclosed wafers.

Figure B, below, is similar to Figure A and qualitatively illustrates that it is possible for a defect distribution in the bulk zone of a silicon wafer to be substantially constant in the axial direction, to be variable in the radial direction, and to have a denuded zone depth that is not substantially constant in the radial direction. The dimensions and locations of the various wafer regions in Figure B are the same as those in Figure A, with the exception that the interface between the first denuded zone and the bulk region varies from $z = 4Z/5$ (at $r = 0$) to $z = 3Z/5$ (at $r = R$).

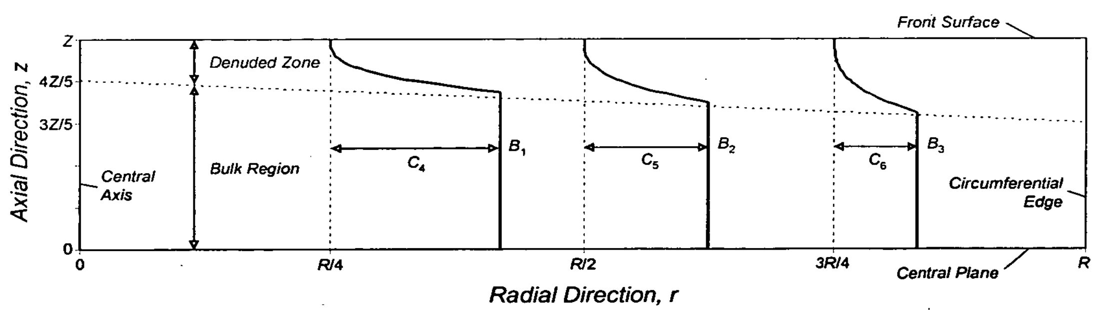

Figure B

Figure B illustrates three qualitative defect distributions B_1, B_2, B_3 at three different radial positions $r = R/4$, $R/2$, $3R/4$ (i.e., the distributions B_1, B_2, B_3 are axial distributions). As illustrated, all three distributions B_1, B_2, B_3 are substantially constant in the axial direction in the bulk region. Similar to Figure A, each of the three distributions B_1, B_2, B_3 has a different concentration in the bulk region (denoted by C_4, C_5, and C_6, respectively). However, for these distributions, the location of the interface between the first denuded zone and the bulk region varies, and the distance of the first denuded zone from the front and surface is not substantially constant in the radial direction.

A silicon wafer that has a denuded zone depth that is controlled to be substantially constant in the radial direction exhibits considerable advantages over those wafers that do not. For instance, if the denuded zone depth is formed to a local depth *greater* than that what was intended, the defects in the bulk region which act as gettering sites become less effective. Because the gettering sites are further removed from metal contaminants deposited on the surface of the wafer during semiconductor manufacturing steps, they are less effective sinks for the metal contaminants. Similarly, if the denuded zone depth is formed to a local depth *less* than that which was intended, semiconductors formed from the wafer can be defective. For example, a semiconductor architecture utilizing trench structures might form trenches deeper than the actual local denuded zone depth, resulting in some of the semiconductor components being undesirably formed in the bulk region.

The applicants respectfully submit that Falster and Nadahara do not disclose or suggest denuded zones whose distances from their respective surfaces are substantially constant in the radial direction. Further, Figure B provides a rationale for concluding that the denuded zone distances are not inherently disclosed or suggested by the applied references. In view of the advantages associated with this characteristic, claims 6 and 13 are allowable over the cited references.

5. New Claims 49-52

Dependent claims 49-52 recite that "the first and second denuded zones are substantially free from" either "oxygen precipitates and bulk stacking faults" (claims 49 and 51) or "bulk stacking faults" (claims 50 and 52), and are patentable for at least the reasons provided above. Claim 49 also recites that "the distances of the first and the second denuded zones from the front and back surfaces . . . are substantially constant in the radial direction," and is also patentable for at least the reasons provided in Section II.B.4 above.

CONCLUSION

In view of the foregoing, entry of the amendments to claims 1, 4, 6, 8, 11, and 13, entry of new claims 49-52, reconsideration and withdrawal of the rejections, and allowance of all pending claims 1, 3-8, 10-13, and 49-52 are respectfully requested.

Should the examiner wish to discuss the foregoing, or any matter of form or procedure in an effort to advance this application to allowance, the examiner is urged to contact the undersigned attorney.

Respectfully submitted,

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